SEMESTER END EXAMINATION APRIL-MAY, 2026

Course Name: - B.Tech (2nd Year) **Semester:- IV**

Paper Name: - Analog Circuits **Paper Code:- NEC 402**

Time - 3 Hrs + 20 minutes per hour extra time for V.I. & examinees with writer. **Max Marks-70**

Instructions:

- The question paper consists of three sections namely A, B, C. All sections are compulsory.
- Section A- Each question carries **3 mark. All questions are compulsory.**
- Section B- Answer any **5 out of 7** given questions. Each question carries **7 marks.**
- Section C- Answer any **2 out of 3** given questions. Each question carries **10 marks.**

Section – A
Multiple Choice Questions

1. Answer all the following questions. **5x3 =15**

i) A. In a half-wave rectifier using an ideal diode and a sinusoidal input, which output quantity is most directly increased by adding a large filter capacitor across the load resistor?

(a) RMS output voltage
(b) Peak output voltage
(c) Peak inverse voltage (PIV) rating required for the diode
(d) Average (DC) output voltage

B. A silicon diode is used in a clipper circuit to limit the positive peak of a signal to approximately 3.3 V. Which configuration achieves this most directly?

(a) Two silicon diodes in series to ground with no DC bias
(b) A diode in series with the signal and a 3.3 V Zener diode to ground in reverse bias
(c) A forward-biased silicon diode in series with a 3.3 V DC source connected to ground
(d) A reverse-biased silicon diode in parallel with the load and no DC source

ii) A. A negative feedback amplifier shows a closed-loop gain magnitude that is lower than the open-loop gain but has a much flatter frequency response. Which statement best explains this behavior?

(a) Negative feedback forces the amplifier to operate only at low frequencies, removing high-frequency content
(b) Negative feedback decreases gain but increases bandwidth, trading excess gain for stability and flatness
(c) Negative feedback increases both gain and bandwidth, hence the flatter response
(d) Negative feedback does not affect bandwidth, only noise performance

B. A Wien-bridge oscillator is designed using an op-amp and an RC network. Which condition must be satisfied for the circuit to start and sustain sinusoidal oscillations at the desired frequency?

(a) Loop gain magnitude equal to 1 and total phase shift around the loop equal to 180°
(b) Loop gain magnitude less than 1 for all frequencies to ensure stability
(c) Loop gain magnitude greater than 1 and total phase shift around the loop equal to 0. or 360°
(d) Phase shift around the loop equal to 90° at resonance

iii) A. An ideal op-amp is configured as a non-inverting amplifier with input resistor *R1* from t output to the inverting input and feedback resistor *R2* from the inverting input to ground. What i the closed-loop voltage gain *Av*?

(a) $A_v = \frac{R_1}{R_2}$

(b) $A_v = 1 + \frac{R_2}{R_1}$

(c) $A_v = 1 + \frac{R_1}{R_2}$

(d) $A_v = -\frac{R_2}{R_1}$

B. An op-amp is configured as an inverting summing amplifier with three input resistors *Ra,Rb,Rc* feeding currents into the inverting input, and a feedback resistor *Rf* from output to inverting input. The non-inverting input is grounded. What is the output voltage expression assuming an ideal op-amp?

(a) $v_o = v_a + v_b + v_c$

(b) $v_o = -R_f(\frac{v_a}{R_a} + \frac{v_b}{R_b} + \frac{v_c}{R_c})$

(c) $v_o = -(\frac{v_a}{R_a} + \frac{v_b}{R_b} + \frac{v_c}{R_c})$

(d) $v_o = R_f(\frac{v_a}{R_a} + \frac{v_b}{R_b} + \frac{v_c}{R_c})$

iv) A. In a flash (parallel) analog-to-digital converter (ADC), what is the primary advantage compared to a successive approximation register (SAR) ADC?

(a) Higher resolution for the same number of comparators
(b) Lower power consumption at high resolutions
(c) Much faster conversion time because all bits are resolved in one step
(d) Requires fewer comparators as resolution increases

B. A digital-to-analog converter (DAC) uses an R-2R ladder network. What is one key advantage of this architecture over a simple weighted-resistor DAC?

(a) It requires only two resistor values, simplifying matching
(b) It eliminates the need for an op-amp as a current-to-voltage converter
(c) It can only implement low-resolution conversions
(d) It inherently corrects for any digital input code errors

v) A. In designing a simple RC phase-shift oscillator using a BJT amplifier that provides a phase inversion, what total phase shift must the RC network contribute at the oscillation frequency?

(a) 30
(b) 270
(c) 180
(d) 90

B. Which type of filter allows signals above a certain frequency to pass?

(a) Low pass
(b) High pass
(c) Band pass
(d) Band stop

Section – B
Short Answer Questions

2. Answer any five of the following questions. 5x7=35

i. Compare the characteristics of voltage, current, transconductance, and trans-resistance amplifiers in terms of their equivalent circuits, input and output resistances(ideal and practical).

ii. Explain the significance of the Barkhausen criterion for oscillation and describe how it applies to an RC phase-shift oscillator.

iii. Compare Rectifier circuits using diode and using op-amp.

iv. Explain the concept of "bias stability" in transistor circuits and discuss why it is crucial for amplifier design.

v. What are the key parameters of a differential amplifier? Define CMRR and explain its importance in practical applications.

vi. Describe the operation of a Schmitt trigger using an OP-AMP and illustrate its hysteresis loop.

vii. Compare Successive Approximation and Flash ADC architectures in terms of speed and complexity. Also Draw the both architectures.

Section – C
Descriptive Questions

2x10=20

3. Answer any two of the following question.

i) Define the four feedback topologies (Voltage Series, Current Series, Voltage Shunt, and Current Shunt). For any one topology, draw the block diagram and derive the expression for the closed-loop gain.

ii) Discuss the high-frequency transistor models for a BJT. Explain how these models are used to determine the cut-off frequency of a single-stage amplifier.

iii) A design requirement calls for a first-order active low-pass filter. Outline the design steps, provide the op-amp based circuits, transfer function, and draw its frequency Characteristics.

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